Photoelectrochemical Semiconductor Heterostructures: From Artificial Photosynthesis to Artificial Retina

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The solar energy-driven photoelectrochemical (PEC) water splitting and photosynthesis have been continuing to drive substantial developments in new materials and methods for optimizing the solar energy conversion and utilization efficiency. Meanwhile, these studies have been inspiring research efforts in utilizing the photoelectrochemical conversion platform to investigate the chemical/biological targets in life sciences. Here, we would like to present our recent works in designing and fabrication of semiconductor heterostructures that are capable of being tailored during synthesis for enhanced solar energy-driven photoelectrochemical energy conversion and utilization. In addition, attributed to their suitable band alignment and excellent photoactivity, these nanostructures are capable of surface functionalization for molecular recognition of a variety of biologically important molecules for cellular signaling and enzymatic functions. Moreover, the high photo-to-electric response, chemical stability and biological benignity of these hetero-nanostructures further can enable direct interfacing with primary neuron cells as artificial retinas for direct photo-stimulated, synchronous image restoration. Continued effort in designing and developing new semiconductor heterostructures may further enable new opportunities in the fields of renewable energy and life sciences.